

Description of Analytical Tools

Name: IWR-MAIN Water Demand Management Suite

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Availability of Technical Support: A summary of IWR-MAIN documentation is available on DWR web site:

<http://www.landwateruse.water.ca.gov/basicdata/urbanwateruse/modeling.cfm>

Categories: Long-term Forecasts of Urban Water Use, Conservation Programs, and Costs and Benefits Associated with Active and Emergency Conservation Program.

Main Features and Capabilities:

- 1 The 'Forecast Manager' within the program estimates water use into the future by customer sectors by user-assigned models for each sector.
- 2 Able to consider multiple factors and projected water use drivers.
- 3 Can be used to perform sensitivity analyses. It allows the user to view different futures based on the changes of one or more attributes.
- 4 Data can be broken down spatially, seasonally, and by use.
- 5 Allows user to analyze variables that affect the rate of water use (per household for the residential sector, and per employee for the industrial sector).
- 6 Allows the user to analyze long-term water demand impacts.
- 7 The 'Conservation Manager' of the program estimates water use efficiency savings by specific end uses.
- 8 Estimates the effectiveness of water conservation. Utilizes a baseline forecast from the Forecast Manager to show how water use efficiency can make an impact on water use.
- 9 Allows user to evaluate forecast long-term water savings of different demand management (conservation) practices.
- 10 Allows the user to evaluate and compare economic metrics of conservation program benefits through a benefit-cost analysis of active conservation programs.
- 11 Allows the user to generate reports created by each of the IWR-MAIN functions.
- 12 Allows the user to aggregate and compare forecast results.
- 13 Provides graphics of forecast and conservation results.
- 14 IWR-MAIN runs on IBM PC compatible-equivalent or higher, with Windows 95/98, NT 4.0, Windows 2000, or Windows XP. It is available on CD.

Applications: The factors which have made this model a choice of water planners nationwide were the abilities of IWR-MAIN to: (1) consider multiple factors and projected water use drivers in estimating future water demand separately for different water use sectors, (2) estimate the effectiveness of water conservation, and (3) perform sensitivity analyses. Uniquely customized IWR-MAIN models have been used by the San Diego County Water Authority, Metropolitan Water District of Southern California, the Oklahoma Water Resources Board, the Phoenix Department of Water and Wastewater, Indianapolis Water Company, City of Binghamton NY, Springfield IL City Water, Southwest Florida Water Management District, and Las Vegas Valley Water District to determine urban water demands based on socioeconomic data, weather and price of water.

Calibration/Validation/Sensitivity Analysis: The computational equations of IWR-MAIN Forecast Manager must be input by the user and can be specified independently for each customer sector. Sector models should be verified and calibrated to local water use conditions before calculating water use in the study area. The IWR-MAIN water estimates may differ from the actual water use, if the equations are not calibrated. Therefore, it is necessary to check the forecasting data and adjust the theoretical water use equations.

The computational equations of the IWR-MAIN Conservation Manager estimate water use by end use, by sector which total to a total sector per unit use. The end use models should be verified and calibrated to local base year conditions.

IWR-MAIN allows the water planner to conduct sensitivity analyses for the forecast of future water use. The program can be used to conduct numerous “what-if” scenarios by making changes in the variables of water demand and to analyze long-term water demand impacts.

Peer Review: After careful study and literature reviews by many water planners across the United States, the IWR-MAIN program was chosen as a standard method for estimating urban water demands.

Anatomy of IWR-MAIN:

-Conceptual Basis: The purpose of the IWR-MAIN application program is fourfold; (1) to use demographic, housing, and business statistics of service areas to estimate the existing and future per unit water demands, (2) to use projections of population, housing, employment, or other demographic unit to derive baseline forecasts of water use, (3) to provide an analysis of existing and projected water demands at the end use level, including the estimation of conservation savings from passive, active, and emergency demand reduction measures, and (4) to allow the user to select least-cost combinations of demand-side alternatives, through benefit-cost analysis, to formulate and optimal, cost-effective long-term water management plan.

-Theoretical Basis: The theoretical basis of IWR-MAIN is to forecast urban water demand, measure conservation savings, and estimate the costs and benefits associated with the implementation of active conservation programs. The IWR-MAIN program has been designed to provide the long-term estimates of urban water use for planning future water demand. Reliable urban water demands are an important factor in water resources planning and management for developing sound water supply plans. IWR-MAIN consists of three parts: The 'Forecast Manager' for water use forecasting, the 'Conservation Manager' for analyzing demand-side alternatives, and the 'Benefit-Cost Tool' within the Conservation Manager for estimating the costs and benefits associated with the implementation of active conservation programs.

The 'Forecast Manager' is used to estimate future water use by sectors/subsectors, by time (annually, seasonally, and monthly), by study area, and by various sectors of water use. Water use can be estimated for the residential, nonresidential, public, and other sectors. The residential, nonresidential, and public sectors can be further disaggregated into subsectors (e.g., residential single-family, residential multifamily, commercial, manufacturing, government, etc.). Water use is estimated on an daily average basis by month, or by total demand by month. Monthly estimates can be aggregated by season. This allows users to account for seasonal and maximum daily variations of water use for facility and demand management planning. The Forecast Manager allows the user to input models that account for factors that affect the rate of water use (gallons per house hold, gallons per employee, etc.). In residential sector, these factors may include household income, household size, household density, weather conditions, and price of water. In the nonresidential sector, these factors may include employment by industry type, labor productivity, weather conditions, and the price of water.

The 'Conservation Manager' allows the user to analyze conservation programs to estimate how much water can be saved by sector, month, and indoor and outdoor end uses. The conservation procedures are utilized to compute water savings by reducing the average per household, per employee, or per unit water consumption of specific end uses. The average per unit water use is disaggregated into end uses (e.g., toilets, showers, process water, cooling, etc.), and conservation programs (e.g., an ultra-low-flush toilet campaign) can be specified to target and reduce water use in specific end use categories.

The Benefit-Cost Tool allows the user to evaluate the costs and benefits associated with the implementation of active conservation programs. This part of the program allows the user to compare various conservation alternatives in terms of their costs and benefits. Then, the results of the benefit-cost procedure can be used to compare supply augmentation alternatives with demand management alternatives using same economic criteria.

-Numerical Basis: IWR-MAIN has been developed to help water planners in their analyses of urban water demands to estimate long-term forecasts of urban water use, to evaluate various demand management alternatives to compute water savings, and to assess the costs and benefits associated with the implementation of active conservation programs. There are three default water use sectors within the 'Forecast Manager': the residential, nonresidential, and other sectors. The user has the option of designating additional sectors. The program generates forecasts for each sector using water equations specified by the user for each sector. The models may be specified as a constant rate of use, a modified rate of use, or multi-variable model. A unique model can be specified independently for each sector.

Other sector or “unaccounted-for” is the estimated total water production minus metered customer water sales. This water use sector may include distribution system leakage, meter slippage, major line breaks, firefighting, un-metered customers, illegal connections, and street washing/construction water. The program calculates other water use from a user specified percent of total water use.

The ‘Conservation Manager’ of the program is designed to compute water savings by reducing water use in specific end use categories. There are three methods to achieve water savings. (1) Active and passive conservation savings occur as units are shifted from lower efficiency classes to higher efficiency classes for each end use. For each end use, this shift may occur passively through the self-retrofit rates, demolition rates, remodeling rates, and annual replacement rates. Alternatively, this shift may occur as the result of utility-sponsored (i.e., active) conservation programs that promote increases in water use efficiency. (2) A change in water/wastewater prices or rate structures may cause changes in the intensity of water use behaviors and the amount of water that is lost to leakage. (3) Mandatory rationing during emergencies can cause water savings by restricting the use of specific water-using appliances and fixtures.

The program estimates average water use by sector for each of the 20 end uses addressed in the conservation savings procedures. Each end use is divided into three classes of efficiency (nonconserving, conserving, and ultraconserving).

The ‘Benefit-Cost’ Tool within the IWR-MAIN Conservation Manager allows the user to compare various conservation alternatives in terms of their costs and benefits to see which program alternative is economically viable to choose. The benefit-cost procedure can be described in terms of three primary components: (1) benefit-cost items (2) accounting perspective (3) economic feasibility tests. Implemented conservation programs result in specific benefits or costs to the various entities affected (i.e., utility, community, society, etc). The accounting perspective allows the user to determine how a conservation program will affect a particular entity, while the economic feasibility tests indicate the economic merits of conservation programs by accounting perspective.

-Input and Output: IWR-MAIN Forecast Manager is designed to estimate water use during the base year, or any other historical year, using the observed values and assumptions about existing end uses of water consumption in the study area. For the residential sector the variables of the economic water use models may include income, household size, housing density, air temperature, rainfall, and marginal price for water and wastewater. For the nonresidential sectors the input variables may include price, cooling degree days, and labor productivity. For all sectors, the user-specified equations predict average rates of per unit water use by month and sector, and by future years. Total water use is estimated by multiplying the estimated average rates of use by the number of users in each sector in the base year and future years. An additional level of disaggregation is introduced in the Conservation Manager to estimate the quantities of water applied to various end uses.

Input requirements for the Forecast Manager depend upon the model specified by the user for each section. The following list summarizes possible data inputs and outputs for the IWR-MAIN model.

Water Use:

- Number of accounts by type
- Water use by customer class
 - Single family
 - Multiple family
 - Commercial
 - Industrial
 - Landscape
 - Unmetered/Unaccounted

Weather Variables:

The weather variables include average daily maximum air temperature, total precipitation, and cooling degree days by month.

Model Parameters:

These variables are the characteristics that can affect the average rate water use in the residential subsectors. The variables are given below.

- Elasticity values of:
 - Median household income
 - Median housing density (units/acre)
 - Average number of persons per household
 - Marginal price
 - Average daily maximum temperature
 - Total precipitation
 - Cooling degree days
 - Other variables

Water Use Efficiency:

- Mechanical measurements
- Fraction of units in each efficiency class
- Intensity values
- Presence of end use
- Natural replacement rates
- Compliance rates

Socioeconomic Inputs:

- Total population
- Persons per household
- Housing units: The standard driver variable of future water use in the residential sector is the number of housing units.
- Housing density:
- Commercial employment
- Industrial employment
- Residential marginal price: The price variables can affect the average rates of water use of both residential and nonresidential water use.

- Household income

Indoor/ outdoor fractions:

To estimate the indoor and outdoor water use components of sector water use, users are asked to provide estimates of the percent of monthly water use that is used for indoor purposes.

Nonresidential predictor variables:

These variables are those characteristics that can affect the average rate of water use (in gallons per employee unit per day) in the nonresidential major industry groups. The typical variables are given below.

- Price: The price variables can affect the average rates of water use of both residential and nonresidential water use.
- Productivity
- Cooling degree days
- Other variables

Outputs from IWR-MAIN can be reviewed as reports, graphics, or exported in html, text or Excel formats. Reports created by IWR-MAIN include the following:

Forecast Manager reports:

- Average per unit rates of water use by month, year and sector.
- Total water use by month, year and sector.
- Water demand can be reported in gallons, million gallons, hundred cubic feet, or acre-feet.
- Water demand can be reported per day or total.
- Input data review report for quality control.

Conservation Manager reports:

- Per unit water use by end use, sector, month, and year.
- Total water use by end use, sector, month, and year.
- Water conservation savings by measure, sector, month, and year.
- Water use and savings can be reported in gallons, million gallons, hundred cubic feet, or acre-feet.
- Water use and savings can be reported per day or total.
- Water use and savings can be reported as baseline, passive, and active conservation levels.
- Estimated indoor/outdoor percentages by sector, month and year.
- Input data review report for quality control.

Benefit-Cost reports:

- Contains the calculated present values for each benefit-cost item by perspective.
- Results of economic feasibility tests of conservation programs by accounting perspective.

Some of the data in these reports are either directly input by the user or are generated by executing various procedures through the program.

Data Management: The program consists of two primary managers: Forecast Manager and Conservation Manager. The 'Forecast Manager' is used to estimate future water use. Water use estimations can be developed for the residential, nonresidential, and other (unaccounted) sectors. The residential, nonresidential, and public sectors can be further disaggregated into subsectors. The 'Conservation Manager' allows the user to analyze demand-side alternatives to quantify the water savings that can be achieved by active and emergency conservation programs. The Benefit-Cost Tool of the Conservation Manager allows the user to run the benefit-cost procedures, which estimate economic metrics of conservation program benefits.

Software: The IWR-MAIN Water Demand Management Suite was developed as a full 32-bit application. The interface is written in Microsoft Access 97 and the graphic module is a customized OCX control. IWR-MAIN is designed for both Microsoft Windows 95 and Microsoft Windows NT 4.0 or higher. The program requires minimum 486/25 (Pentium/133 recommended), minimum 16MB RAM (32MB RAM recommended), minimum VGA 640x480, and minimum 40MB free space. CD-ROM drive also required. A user's provides users with not only an understanding of the operational functions of IWR-MAIN but also a theoretical background on water demand analysis. The manual also describes step-by-step procedures required to operate the 'Forecast Manager,' the 'Conservation Savings Manager,' and the 'Benefit-Cost Manager,' which are the essence of water demand analyses.